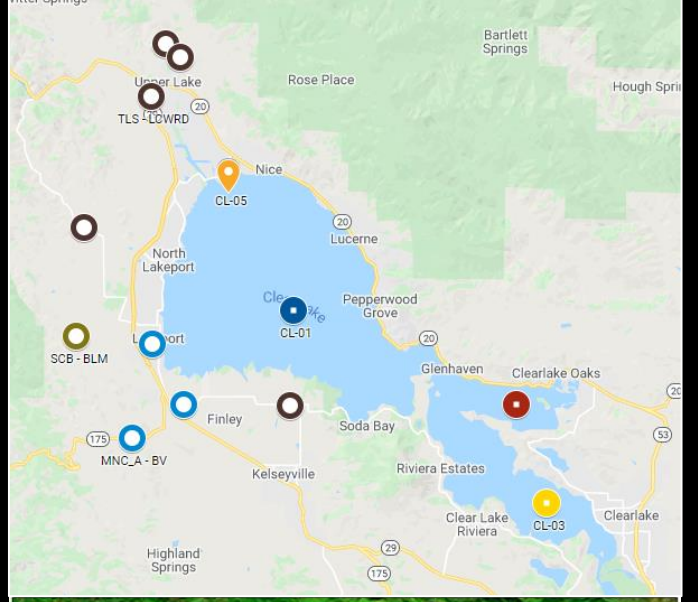
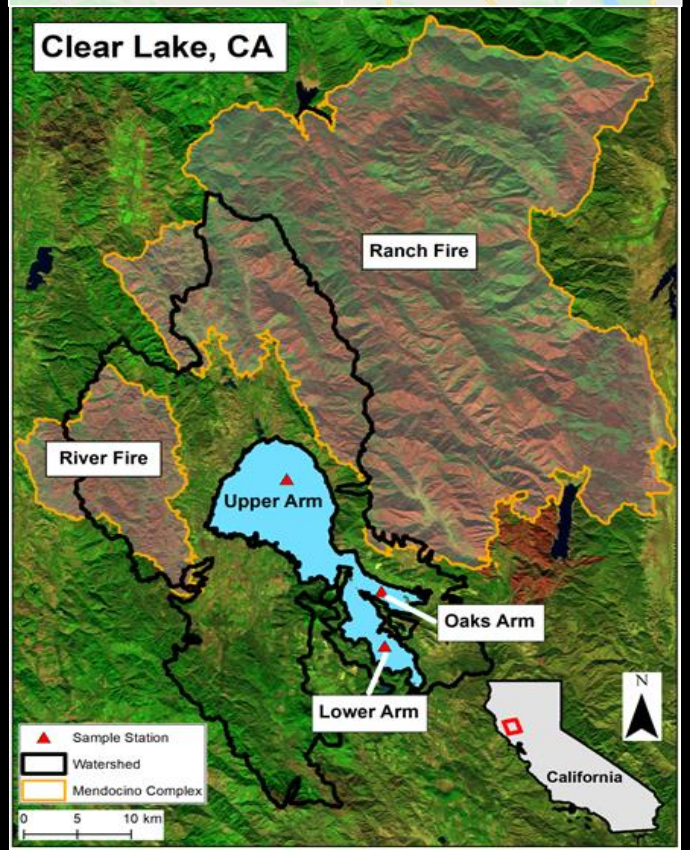
Clear Lake LAKE WQ Monitoring $$ Updates

Angela De Palma-Dow
Program Coordinator
County of Lake Water Resources

Clear Lake WQ Monitoring Activities

- Five Programs & Lead Agencies
  - Ambient Lake WQ - CDWR & County
  - TMDL / impaired Water Body Chl-A – CRWQCB & County
  - Quagga Mussel Monitoring – Veliger Tows & Select WQ – CDFW & County
  - Nutrient Sediment Core Sampling – County & UC Davis





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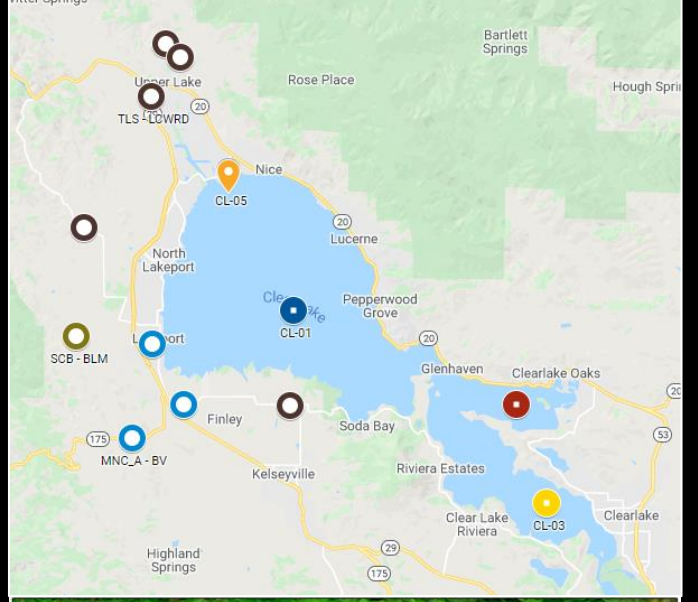
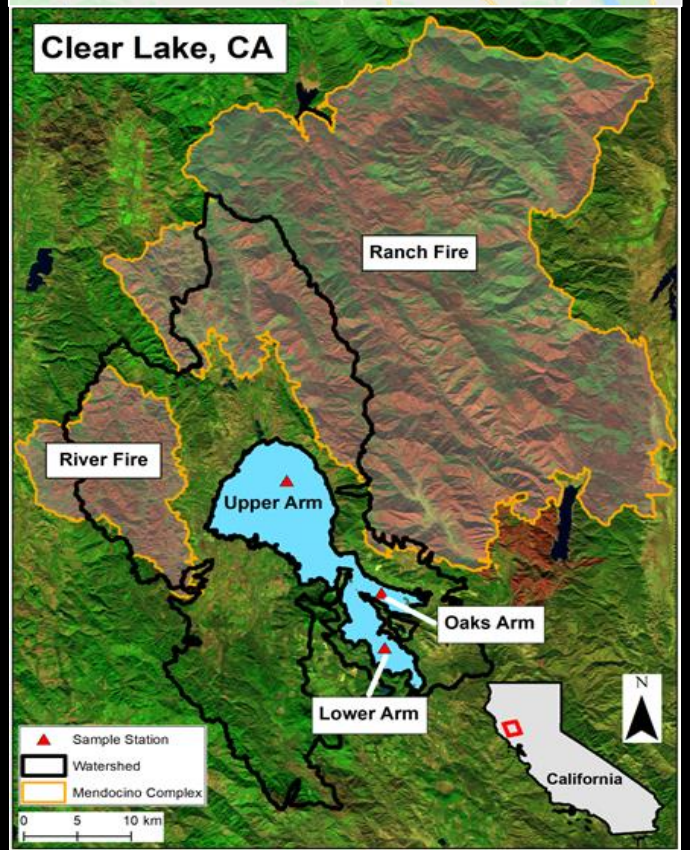
  - Quagga Mussel Monitoring – Veliger Tows & Select WQ – ~~CDFW~~ Lab only & County
  - Nutrient Sediment Core Sampling – County & UC Davis





Parameter List DWR Clear Lake WQ Ambient Sampling 10x year

DWR Lake Analysis	Current EPA Method - Active
ALKALINITY-Total	Std Method 2320 B (Filtered)
ALUMINUM-Dissolved	EPA 1638 (D)
ALUMINUM-Total	EPA 1638 (T)
AMMONIA-Dissolved	EPA 350.1
AMMONIA-Total	EPA 350.1 (Total)
ARSENIC-Dissolved	EPA 1638 (D)
ARSENIC-Total	EPA 1638 (T)
BORON-Dissolved	EPA 200.7 (D)
CADMIUM-Dissolved	EPA 1638 (D)
CADMIUM-Total	EPA 1638 (T)
CALCIUM-Dissolved	EPA 200.7 (D)
CALCIUM-Dissolved	
CALCIUM-Total	EPA 200.7 (T)
CHLORIDE-Dissolved	EPA 300.0 28d Hold
CHROMIUM-Dissolved	EPA 1638 (D)
CHROMIUM-Total	EPA 1638 (T)
CONDUCTANCE Specific-Field	EPA 120.1 (Field)
COPPER-Dissolved	EPA 1638 (D)
COPPER-Total	EPA 1638 (T)
HARDNESS-Dissolved	Std Method 2340 B (D)
HARDNESS-Total	Std Method 2340 B (T)
IRON-Dissolved	EPA 1638 (D)
IRON-Total	EPA 1638 (T)
LEAD-Dissolved	EPA 1638 (D)
LEAD-Total	EPA 1638 (T)
MAGNESIUM-Dissolved	EPA 200.7 (D)
MAGNESIUM-Total	EPA 200.7 (T)

DWR Lake Analysis	Current EPA Method - Active
MANGANESE-Dissolved	EPA 1638 (D)
MANGANESE-Total	EPA 1638 (T)
MERCURY-Total	EPA 1631 E (T)
NICKEL-Dissolved	EPA 1638 (D)
NICKEL-Total	EPA 1638 (T)
NITRATE + NITRITE-Dissolved	Std Method 4500-NO3-F (28Day)
NITRATE AS N-Dissolved	
NITRATE-Dissolved	EPA 300.0 28d Hold
NITROGEN KJELDAHL-Total	EPA 351.2
NITROGEN KJELDAHL-Soluble	
NITROGEN ORGANIC-Dissolved	EPA 351.2/EPA 350.1 (Dissolved)
NITROGEN ORGANIC-Total	EPA 350.1/EPA 351.2 (Calc)
NITROGEN-Dissolved (NO2, NO3, TKN & CALC)	
NO2+NO3 as N-Dissolved	
OROTH-PHOSPHATE-Dissolved	EPA 365.1 (DWR Modified)
PHOSPHORUS-Total	EPA 365.4
POTASSIUM-Dissolved	EPA 200.7 (D)
SELENIUM-Dissolved	EPA 1638 (D)
SELENIUM-Total	EPA 1638 (T)
SILVER-Dissolved	EPA 1638 (D)
SILVER-Total	EPA 1638 (T)
SODIUM-Dissolved	EPA 200.7 (D)
SOLIDS DISSOLVED-Total	Std Method 2540 C
SOLIDS SUSPENDED -Total	EPA 160.2
SULFATE-Dissolved	EPA 300.0 28d Hold
ZINC-Dissolved	EPA 1638 (D)
ZINC-Total	EPA 1638 (T)

Ambient Lake WQ ~2020

Program Costs between

~$100,000
-Top, Bottom
-4 sites
-10x year

CDWR scheme

~ $600,000
-4 sites
-all depths
-10x year

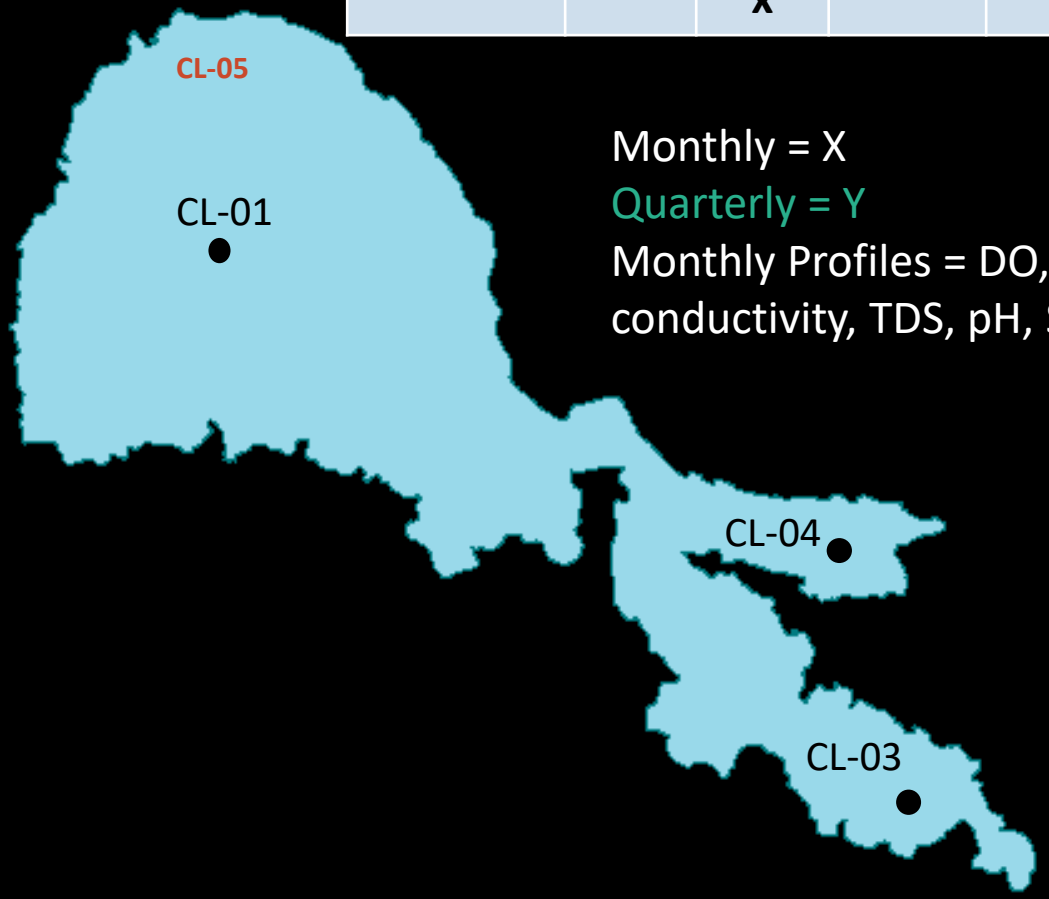
Lab Analysis Clear Lake WQ Parameter Estimates - as per CDWR list current 2019-2020				
Baseline (for one single site, either CL-01, CL03, CL-04, CL-05)				
	Factor	**Alpha (Ukiah)**	**CalTest (Napa)**	**TERC (UC Davis)**
ESTIMATE 1 site (surface only):	1x	$ 1,390.00	$ 1,444.50	$2,240
ESTIMATE 1 site (surface & Bottom):	x2	$ 2,780.00	$ 2,889.00	$ 4,479.80
ESTIMATE 1 site (every 3 m at each site):	x13	$ 18,070.00	$ 18,778.50	$ 29,118.70
Surface Only (0.5m)				
ESTIMATE for 3 sites (surface only):	x1	$ 4,170.00	$ 4,333.50	$4,146
ESTIMATE for 4 sites (surface only):	x1	$ 5,560.00	$ 5,778.00	$5,099
ESTIMATE for 3 sites x 10 months (surface only) :	x1	$ 41,700.00	$ 43,335.00	$41,457
ESTIMATE for 4 sites x 10 months (surface only):	x1	$ 55,600.00	$ 57,780.00	$50,986
Surface and Bottom (0.5 m & either 12m, 9m, 6m depending on arm being sampled)				
ESTIMATE for 3 sites (surface and bottom):	x2	$ 8,340.00	$ 8,667.00	$ 8,291.40
ESTIMATE for 4 sites (surface and bottom):	x2	$ 11,120.00	$ 11,556.00	$ 10,197.20
ESTIMATE for 3 sites x 10 months (surface and bottom):	x2	$ 83,400.00	$ 86,670.00	$ 82,914.00
ESTIMATE for 4 sites x 10 months (surface and bottom):	x2	$111,200.00	$115,560.00	$ 101,972.00
Every 3 m (standard for DWR, includes 13 samples for each one event)				
ESTIMATE for 3 sites (every 3m):	x12	$ 50,040.00	$ 52,002.00	$ 49,748.40
ESTIMATE for 4 sites (every 3m):	x13	$ 72,280.00	$ 75,114.00	$ 66,281.80
ESTIMATE for 3 sites x 10 months (every 3m):	x12	$500,400.00	$520,020.00	$ 497,484.00
ESTIMATE for 4 sites x 10 months (every 3m):	x13	$722,800.00	$751,140.00	$ 662,818.00
Lake County has already committed to funding this parameter - Chl-a				
Chl-a estimates surface x 10x:			$ 9,000.00	$6,240
Chl-a estimates surface & bottom 10x:			$ 18,000.00	$12,480
Add $1000 + / - to these total #s for replicates, duplicates, shipping, packing, and handling				
Lake Samples are collected 1x a month for 10 months of the year				
Samples are collected from 4 sites (started in 2018 post fire)				
Ideal schema would maintain 4 sites for 10 months with ALL parameters				
THIS DOES NOT INCLUDE LABOR COST, WHICH ARE SIGNIFICANT FOR SAMPLE PREP / STAFF TIME / AND FILTERED / DISSOLVED SPECIES				

WRD Trial Clear Lake Sampling Scheme – Dec 2020

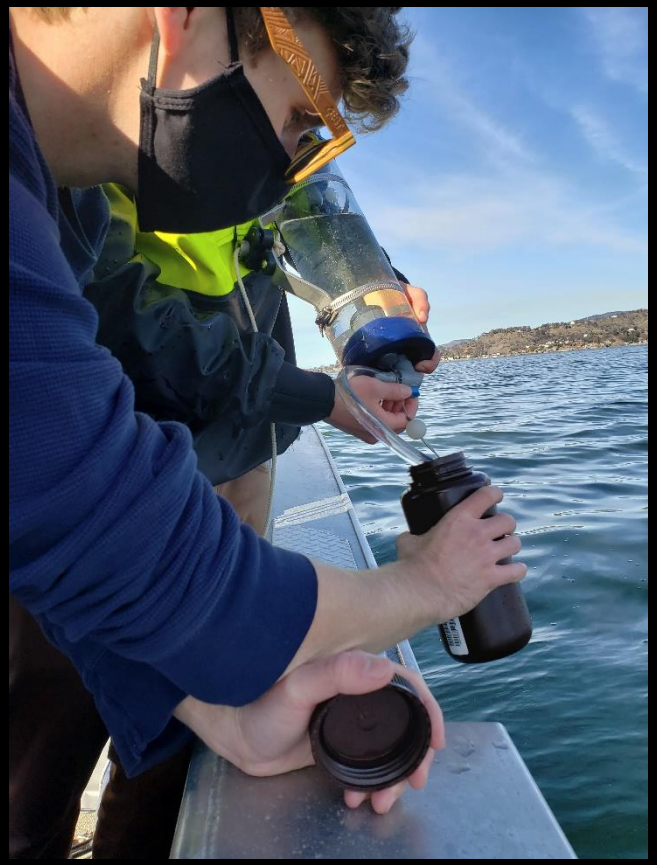
- Costs annual ~$100,000
- Funding Sources Vary
- Internal County Cannabis Tax Grant (Clear Lake Water Quality ~ $15,000)
- US EPA NEIEN Networking Grant (HPUL)
- General WRD Budget (Lakebed Management Fees)
- AmeriCorps Civic Spark Fellowship Program (Labor and analysis help)

Ambient Lake WQ ~2021

Depth	Chl-a	TP / TN	Ortho-P	TSS	Turbidity	Metals +Fe, Al, Ca	Hardness, Alkalinity	Water Color
0.15 m	X	X	X	X	X	Y	Y	X
3m	X							
Middle								
<1m Bottom	X	X	X	X	X	Y	Y	X
Sediment		X						



Monthly = X
Quarterly = Y
Monthly Profiles = DO, temp, conductivity, TDS, pH, Secchi



What do we notice about this sampling scheme?

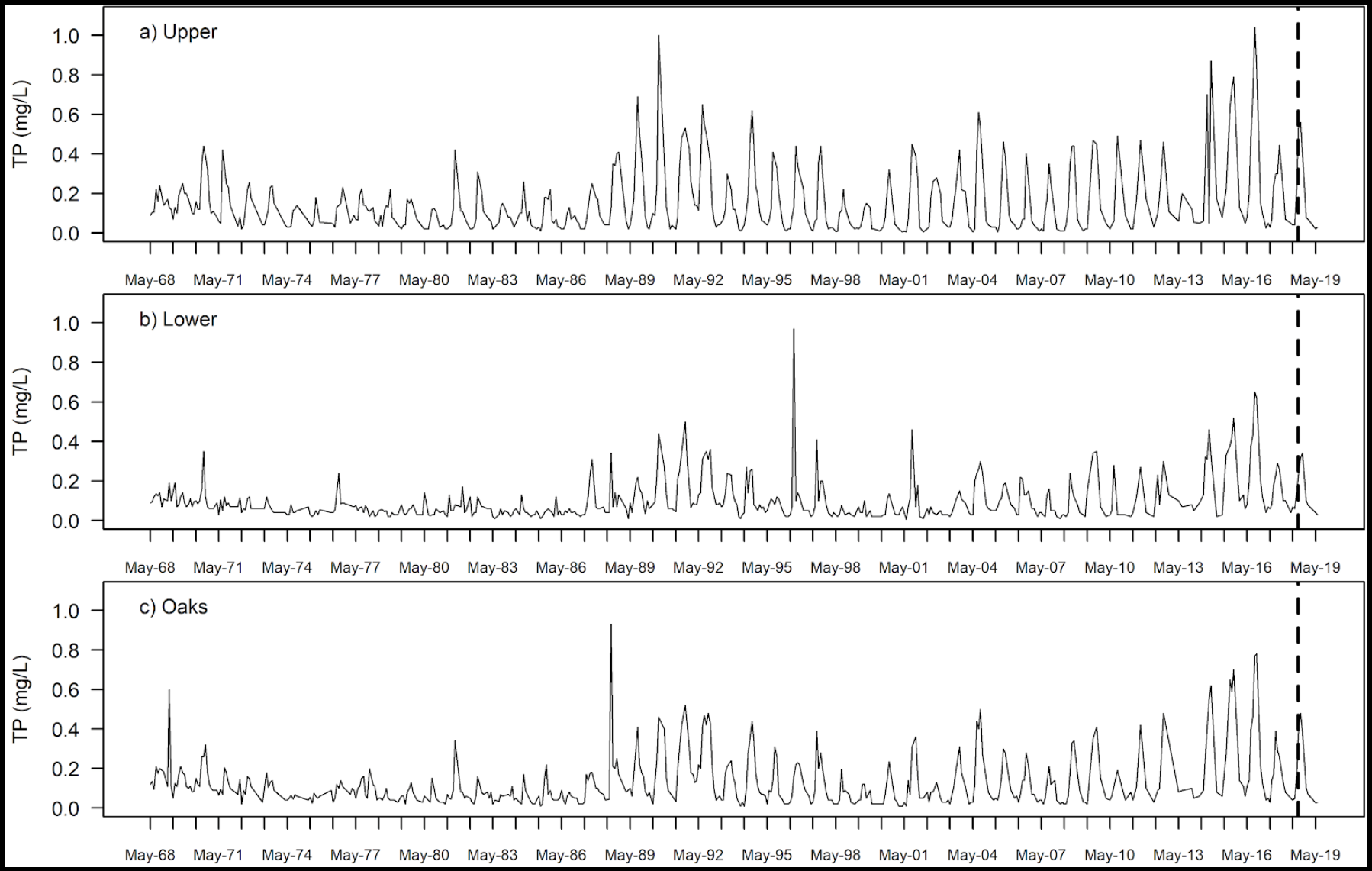
- No Dissolved nutrients
  - Just SRP / Ortho phosphate
- Not all depths
- Trying for sampling every month
  - Data gaps from fire events
  - Data gaps drought /low water levels
- Does all the data mean *<u>something?</u>*
- *Is there meaningful data we are not collecting?*
  - TOC? DOC? Ammonia / NH4?
  - Biota: Phyto / Zoops?

Why do we need this data?

Not a deep data dive, just example of the type of info we have available now to help us make management decisions!

Ambient Lake WQ ~$600,000

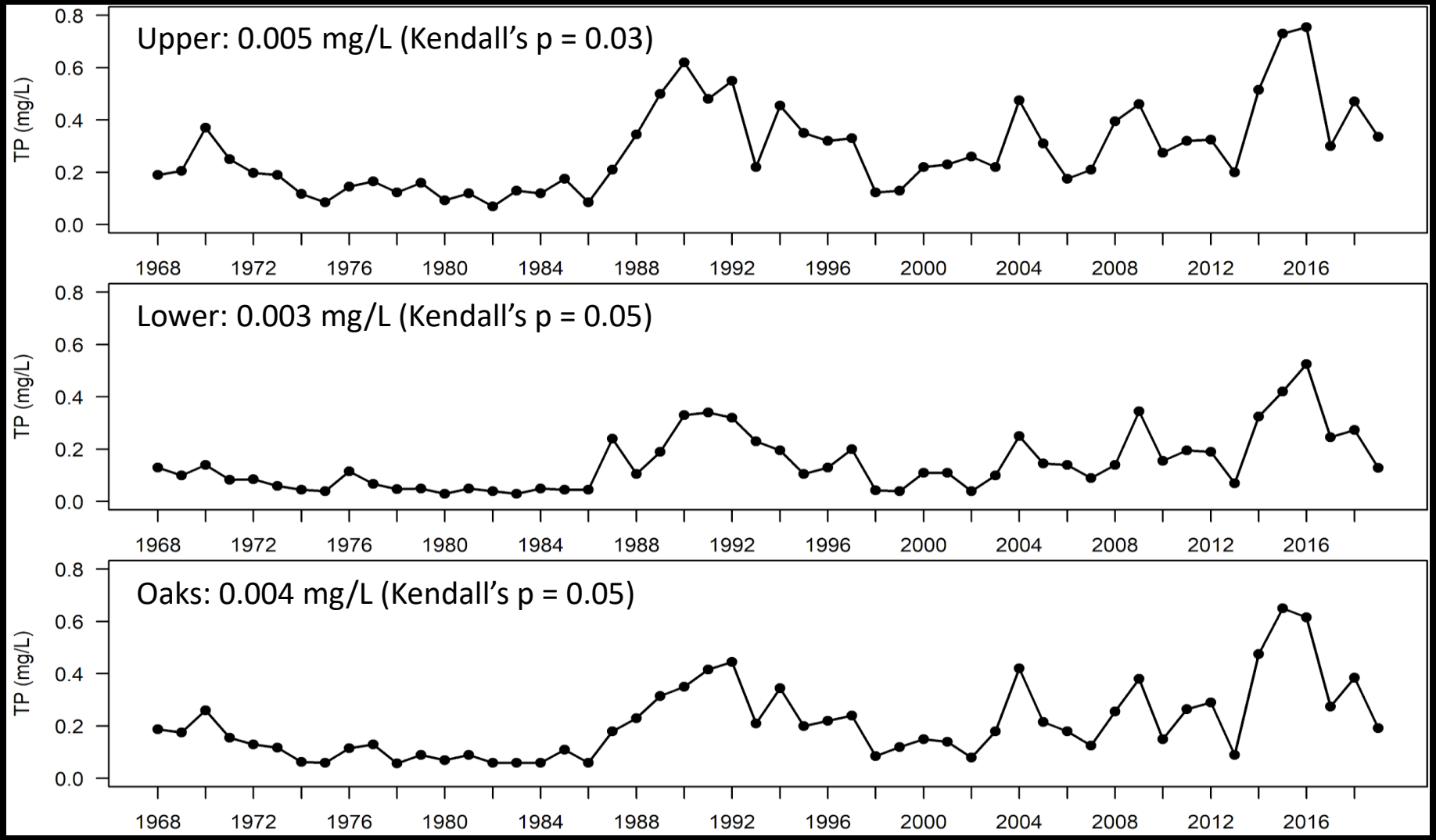
Ex. Long Term Annual TP – Monthly medians (MESSY!)



Long-term surface TP (July-Oct)

Increasing over time? Yes!

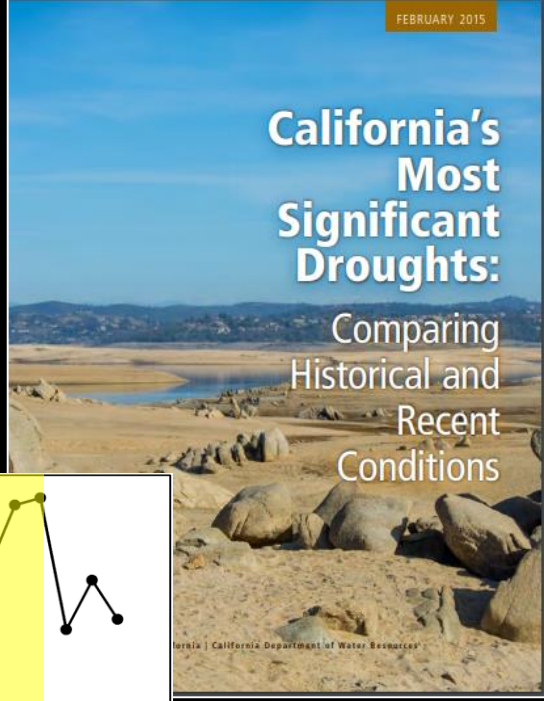
Thiel-Sen slope annual rate of increase (3-5µg/L)

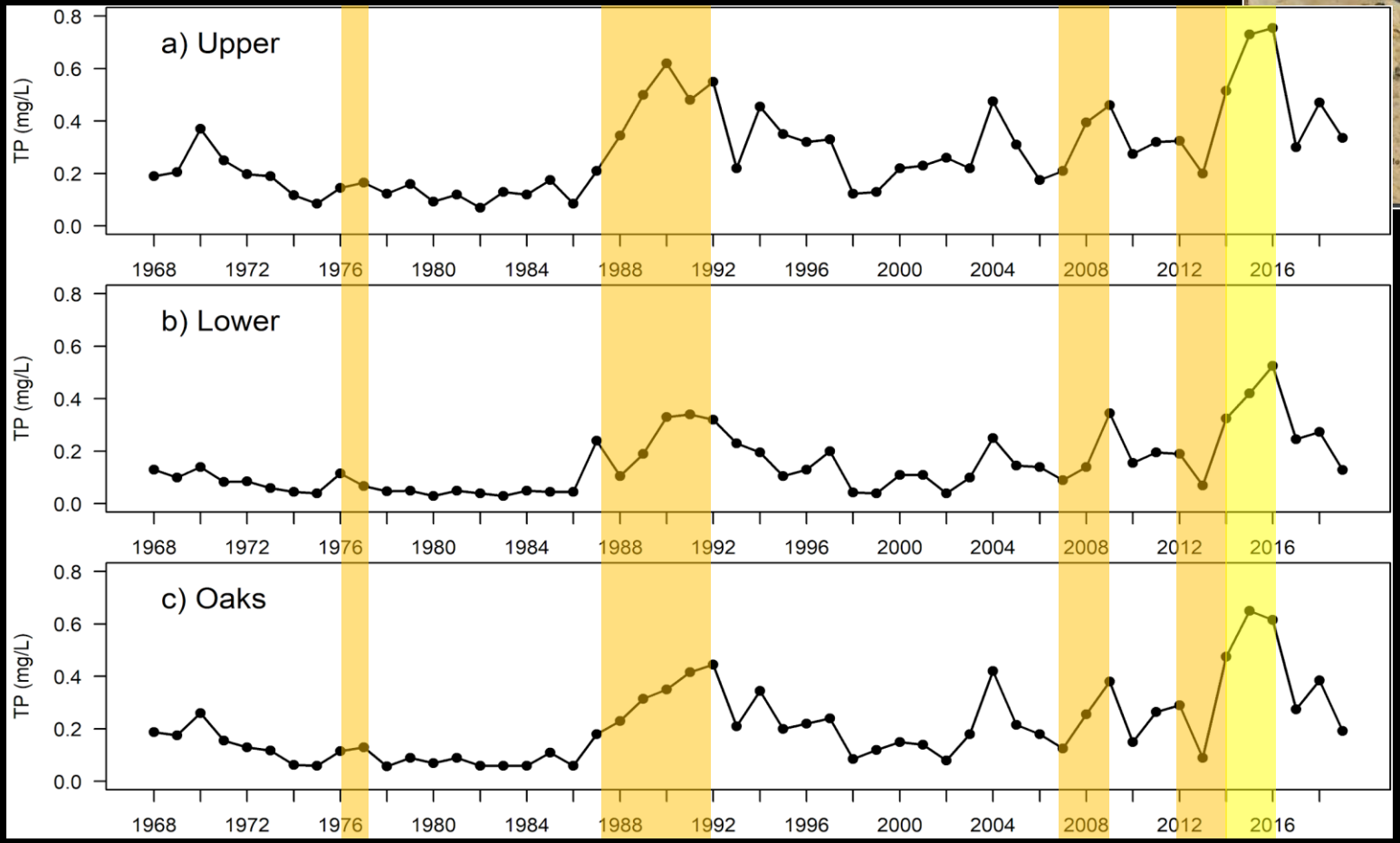


Long term data needed for accurate management decisions

Example: Drought influence apparent with long term dataset

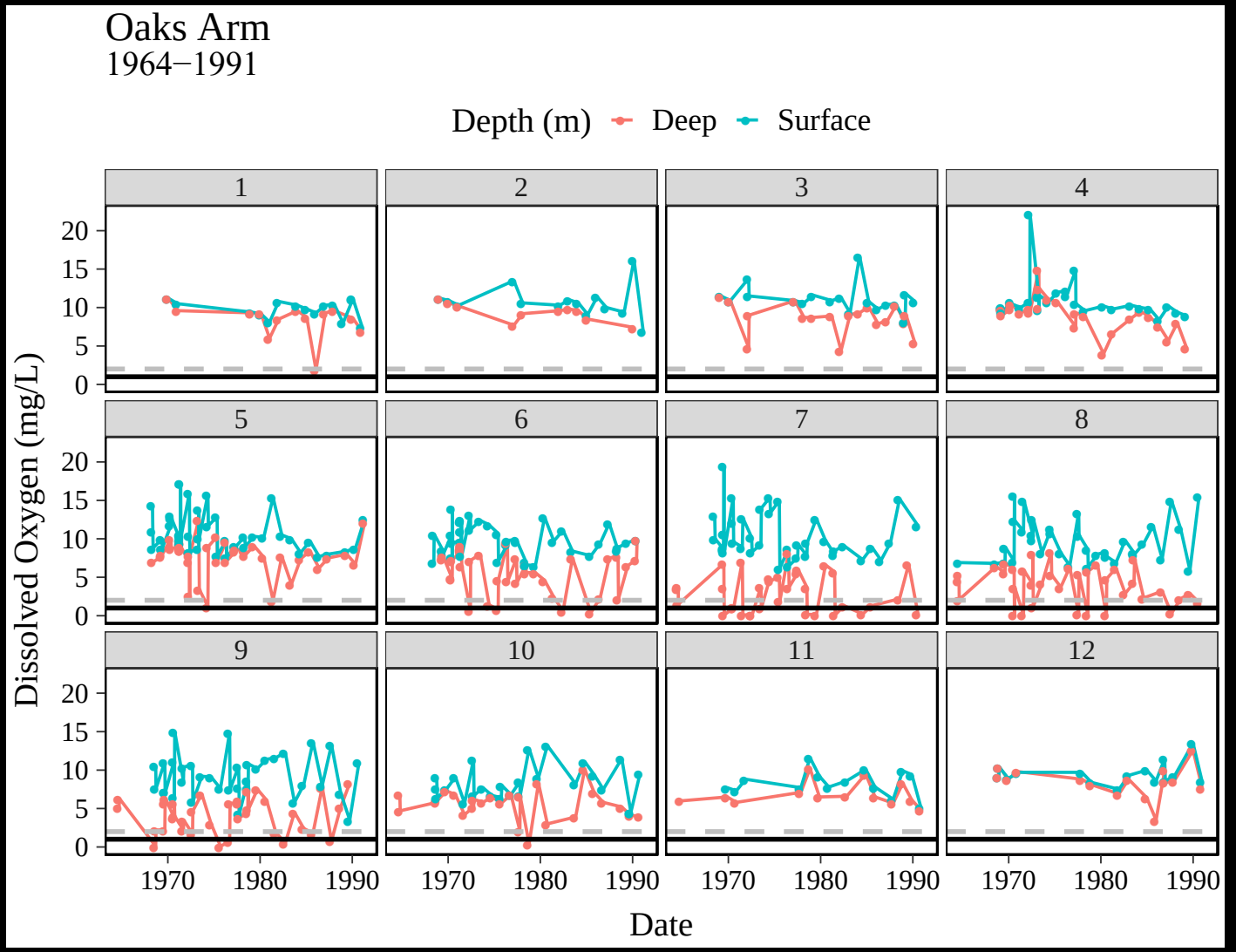
TP not associated with Wildfire, Precip, but winter max air temp, negative with precip = DROUGHT conditions





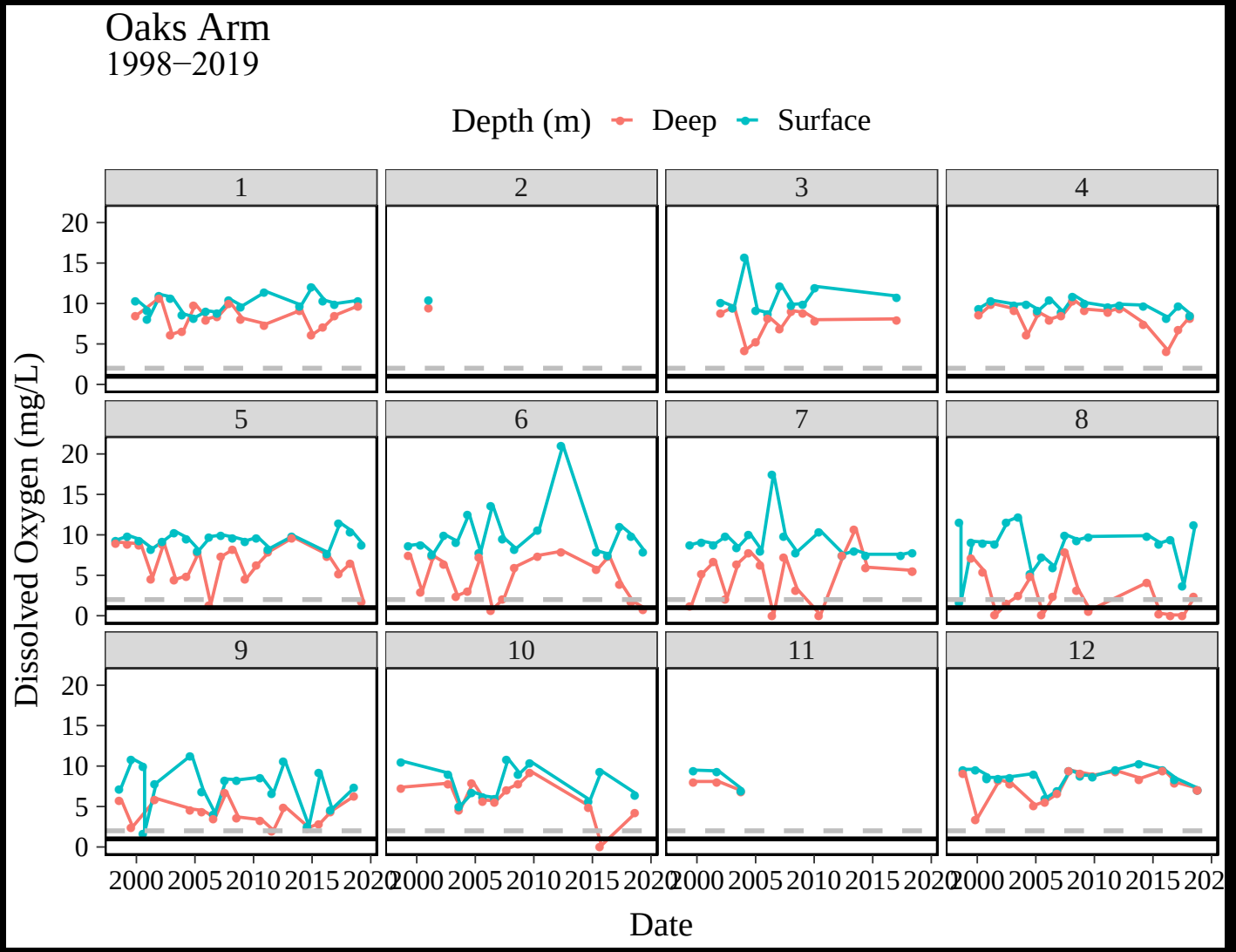
DO by month

gray = hypoxia (< 2 mg/L)
black = anoxia (< 1 mg/L)



DO by month – 1998-2019

gray = hypoxia (< 2 mg/L)
black = anoxia (< 1 mg/L)



DO over time– Surface and Bottom

gray = hypoxia (< 2 mg/L)
black = anoxia (< 1 mg/L)
- Monthly
-Median

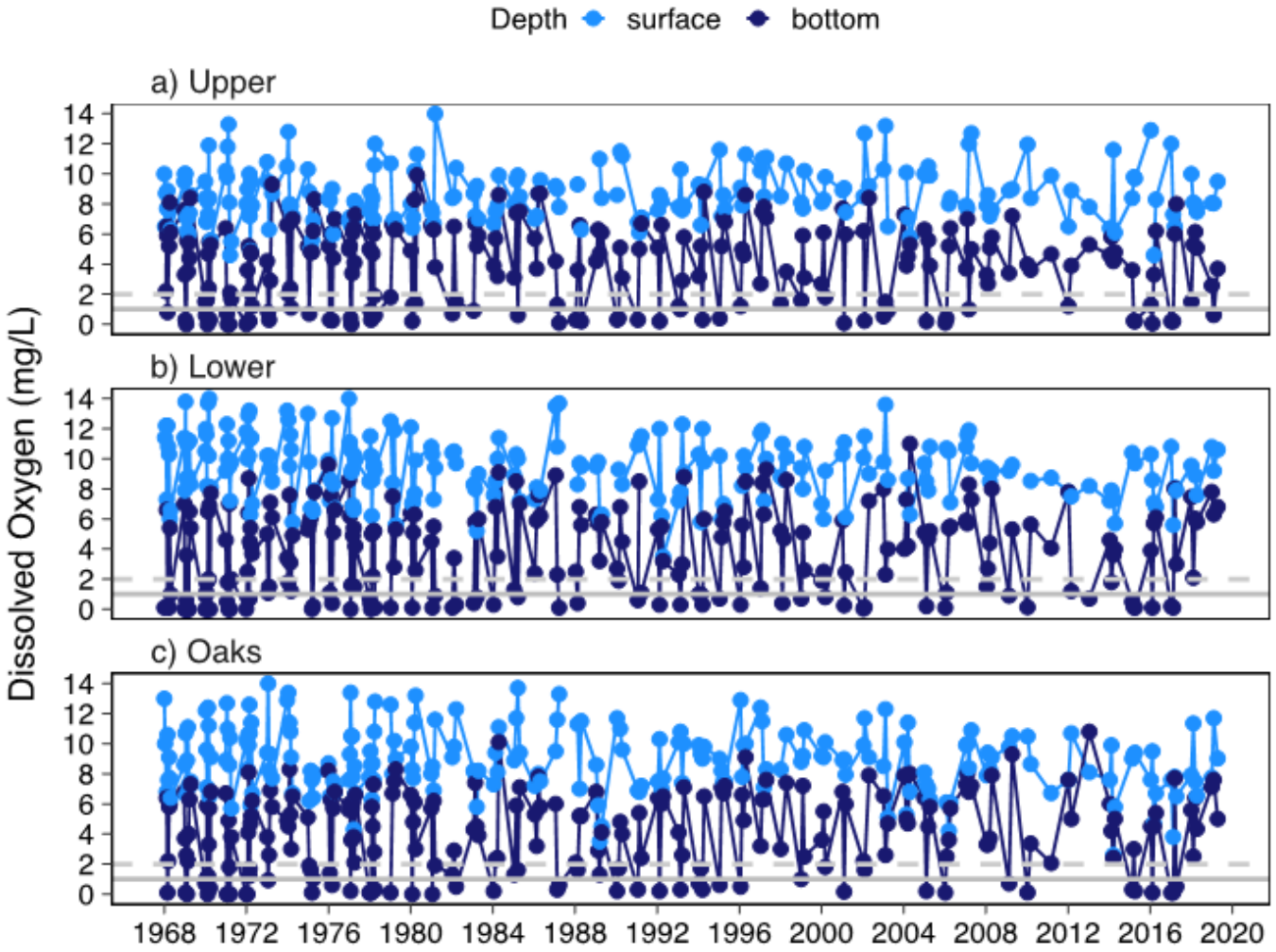


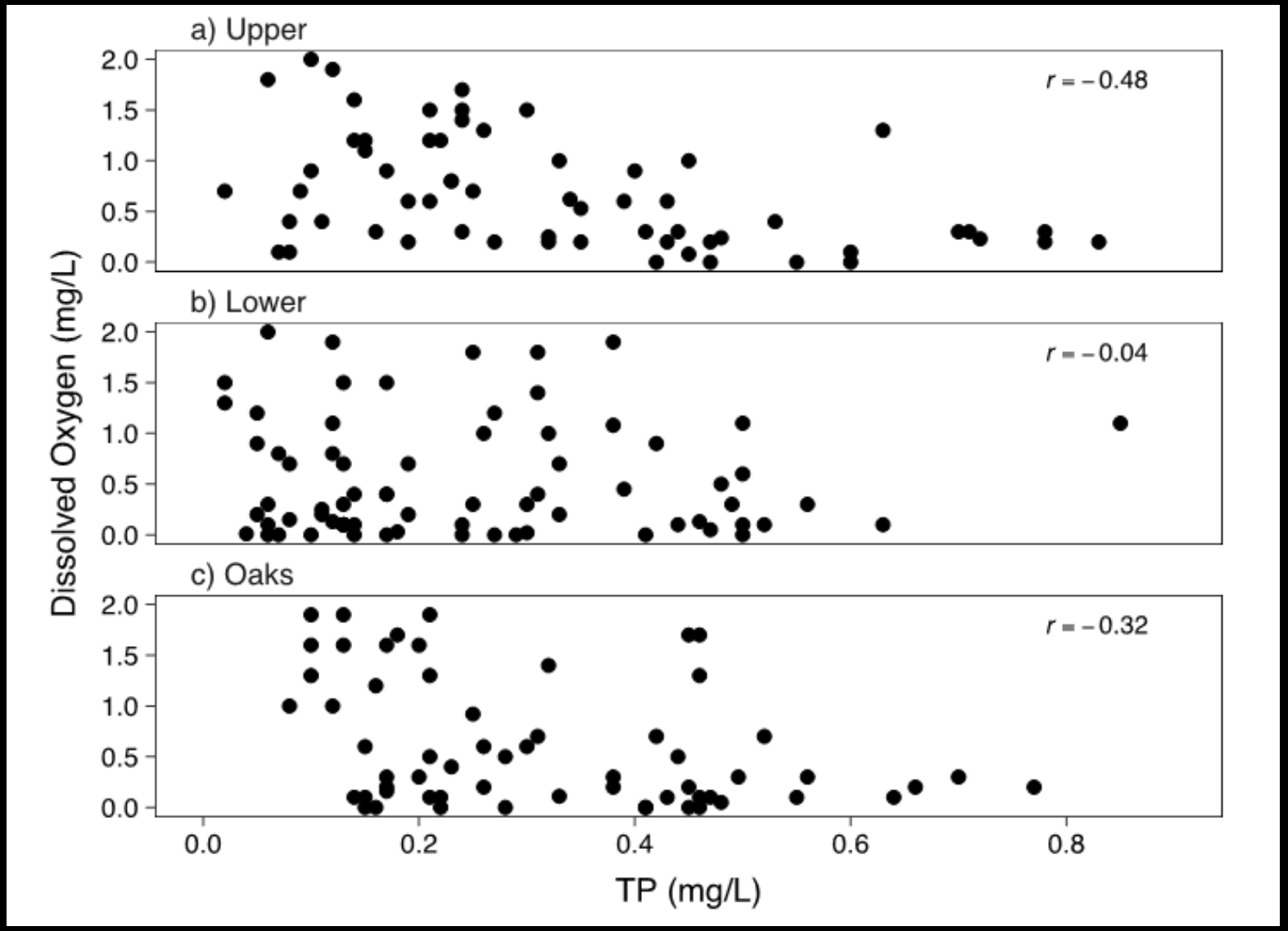
Figure S8. Monthly surface and bottom DO for July-October for a) Upper arm, b) Lower Arm, and C) Oaks arm.

Example: # Days Oaks Arm Anoxic – DO < 1 mg/L

- June: 6
- July: 11
- Aug: 12
- Sep: 5
- Oct: 2
- 1964-1991 – 25 anoxic days, total samples = 633, 4%; deep samples = 309, **8%**
- 1998-2019 – 11 anoxic days, total samples = 320, 3.4%; deep samples = 157, **7%**

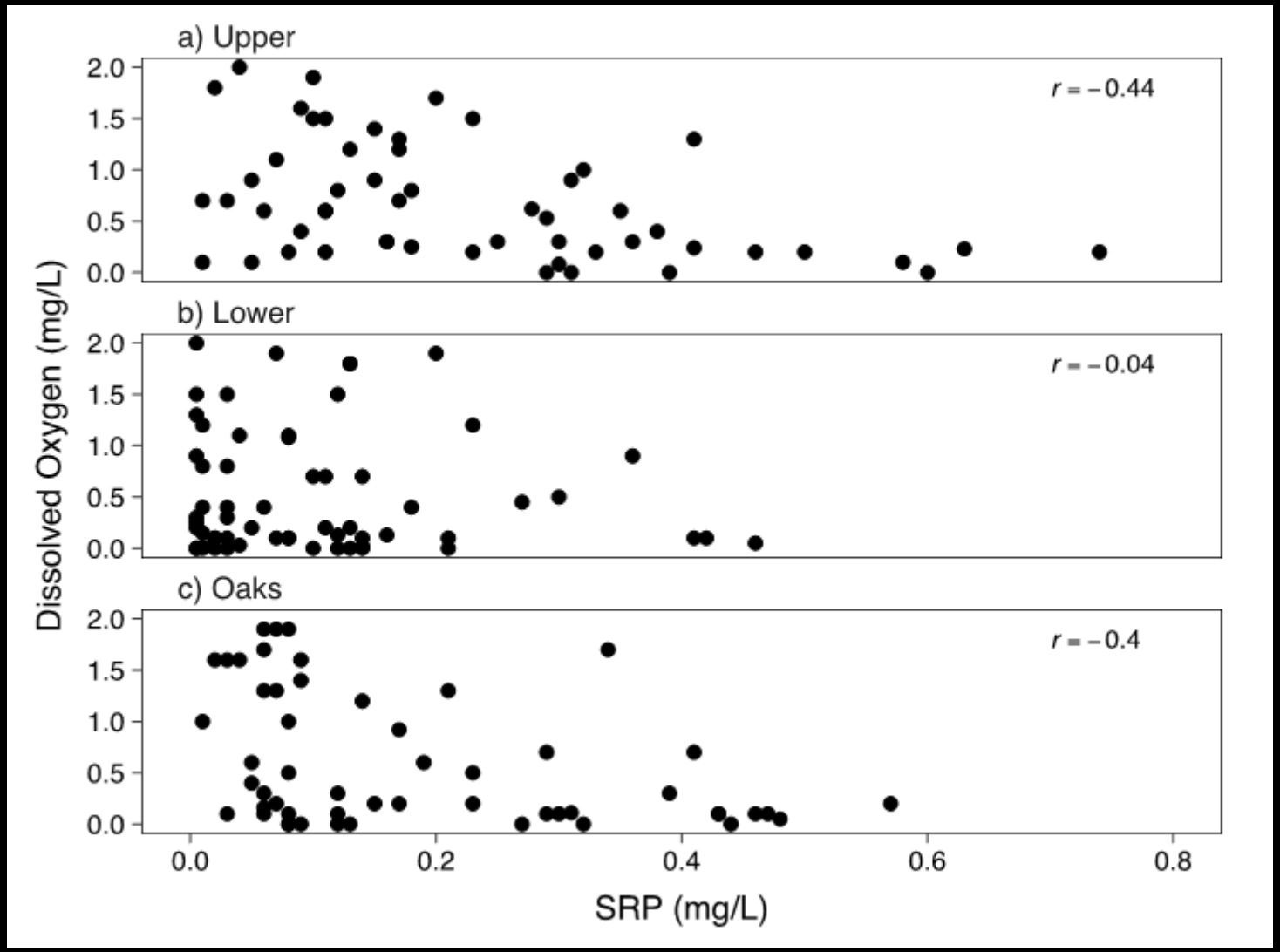
Look at relationships

July-Oct **TP** vs hypoxic DO – spearmans correlation



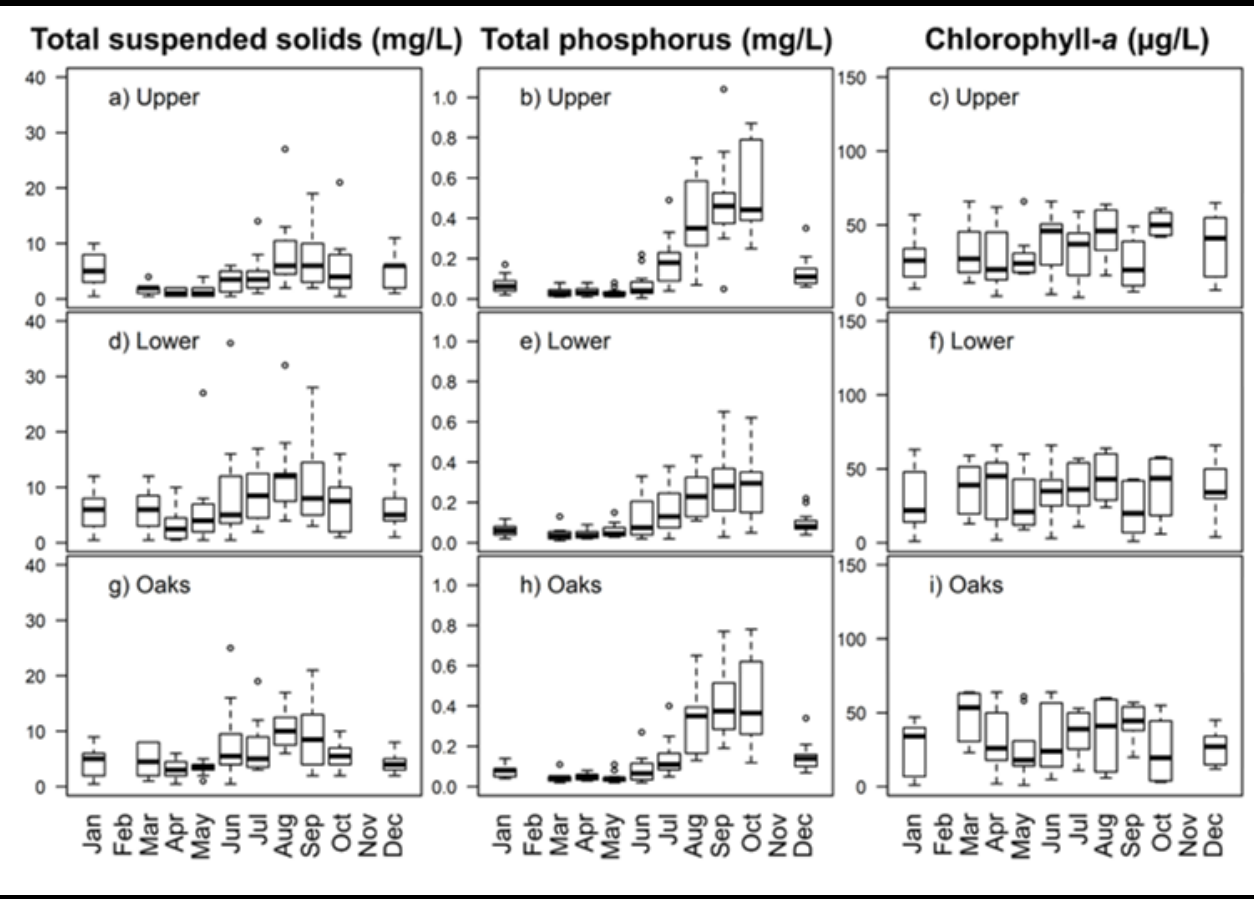
Look at relationships

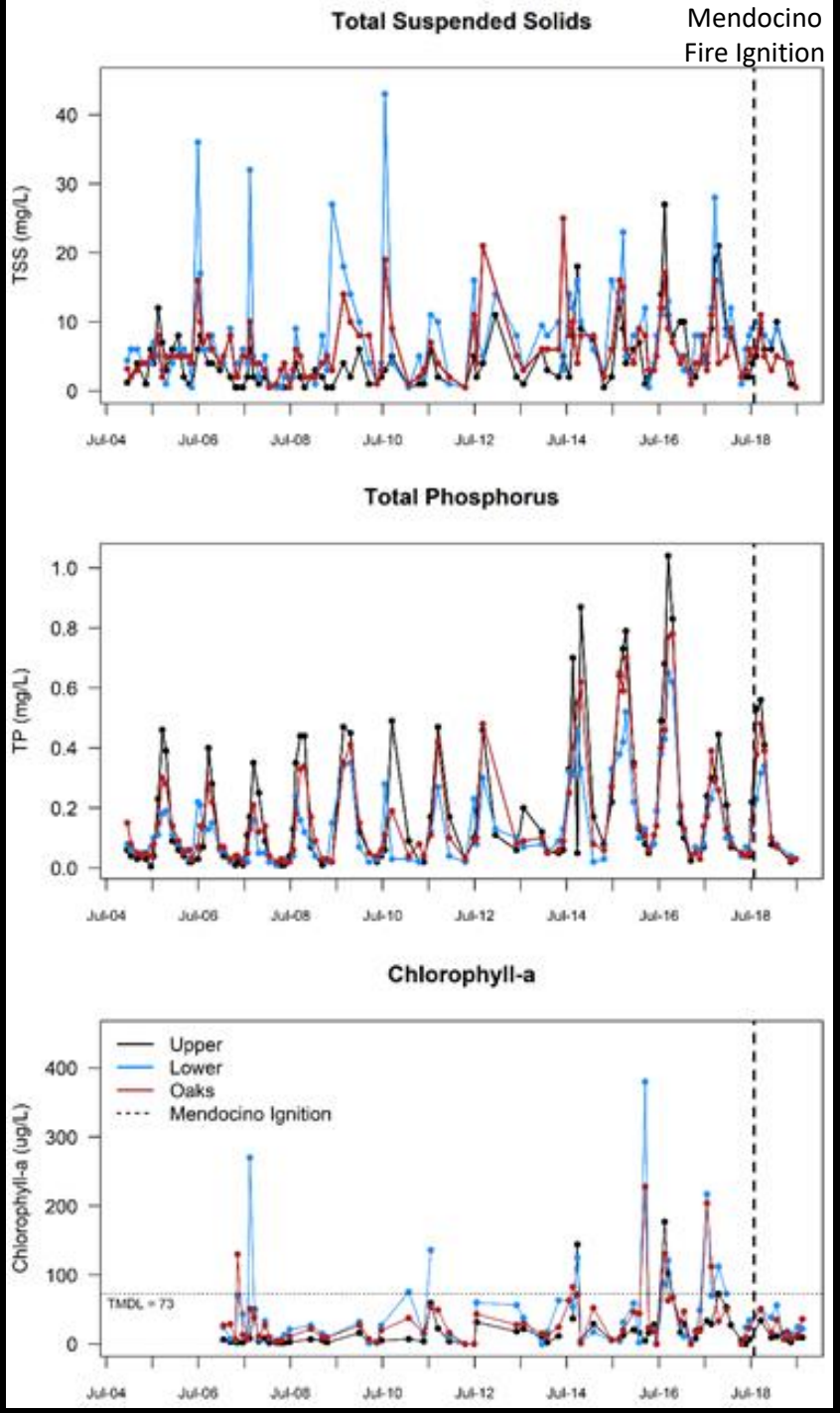
July-Oct **SRP** vs hypoxic DO – spearmans correlation



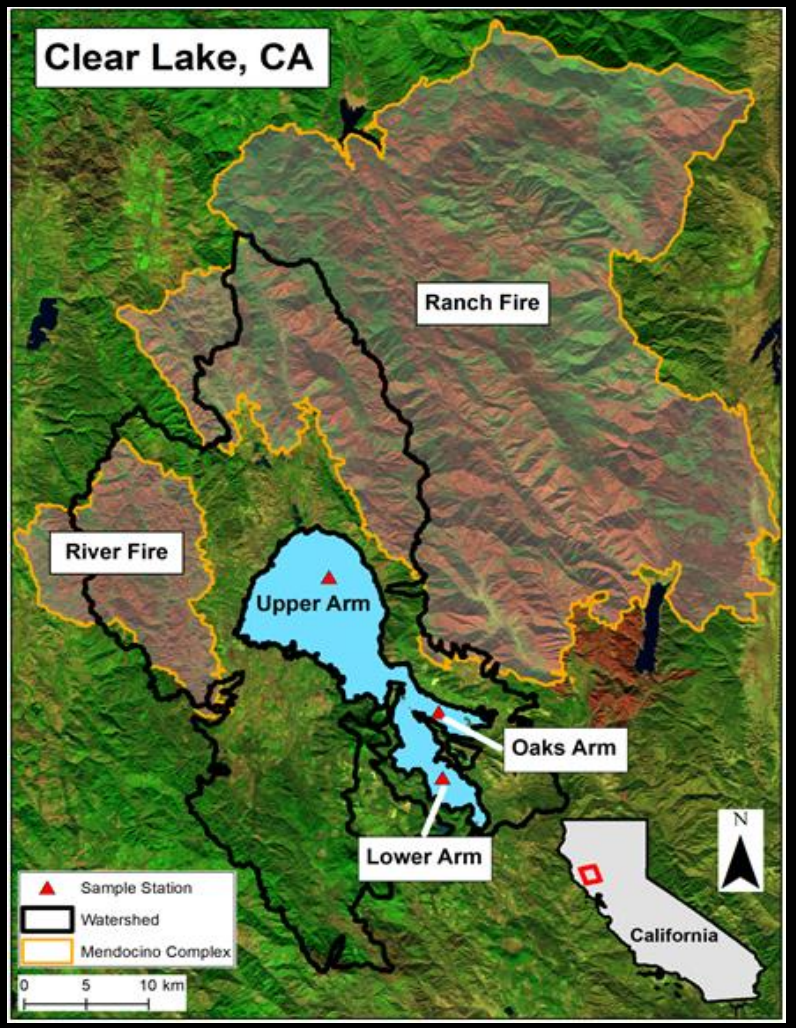
Specific info for periods of interest

Nutrient & HABs Blooms Season: June - October





Useful for Wildfire Impact Research

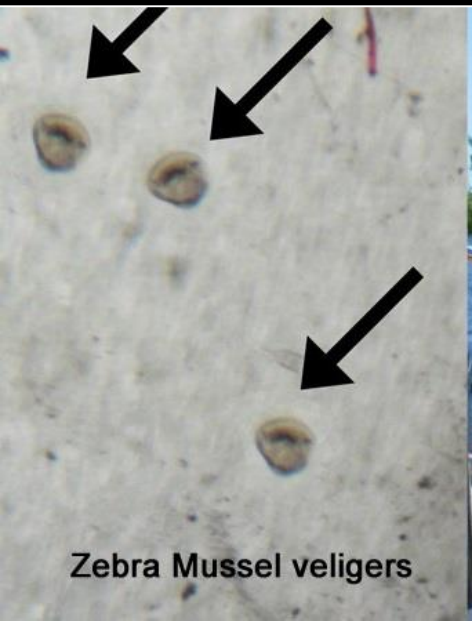


Q/Z Veliger & WQ Monitoring Tows

Required now 2-4x Clear Lake, Blue Lakes, Pillsbury, Indian Valley

- $11,000 Staffing estimates

-Needed to get grant $$



Division of Boating and Waterways

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Quagga and Zebra Mussel Infestation Prevention Grant Program

- High Ca+ in Clear Lake
- High QZ Grant Priority

Table 1 Average water quality measurements from Clear Lake and Indian Valley Reservoir (2016-2018) and parameter ranges shown to be suitable for the growth and establishment of (Adult) Q/Z mussels. All data is provided by A. Montalvo (CDFW) unless otherwise noted.

Year	Temp (°C)	Conductivity (mS/cm)	pH	D.O. (mg/l)	Total Hardness[1] (mg/L CaCo3)	Salinity (ppm)	Total Calcium[1] (mg/L)
Clear Lake							
2016 May	22.3	0.4	8.7	6.6	173.0	0.2	30.0
2016, Nov	16.7	243.0	9.5	3	131.0	0.1	23.0
2017, April	14.4	0.3	8.3	1.2	113.0	0.1	21.0
2017, July	26.0	263.0	10	7.0	123.0	0.1	22.0
2017, Oct	17.4	257.1	9.1	2.9	127.0	0.1	23.0
2018, April	16.0	243.3	8.6	1.6	N/A	0.1	N/A
2018, Oct	18.5	304.9	7.5	6.2	N/A	0.2	N/A
Indian Valley Reservoir							
2016, Dec	10.7	0.3	7.9	10.1	N/A	0.2	N/A
2017, June	22.8	223.4	8.7	6.9	N/A	0.1	N/A
2017, Oct	18.9	222.5	8.4	3.5	N/A	0.1	N/A
2018, Oct	19.9	253.7	8.1	6.3	N/A	0.1	N/A
Preferred Range for Q/Z mussels	6-32[2]	>22µS/cm[3]	6.5-9.5[2]	>2-6[2]	100-420[2]	0-12[3]	>12[2]

[1] Data provided by DWR (Surface 0.5 m) Water Data Library http://wdl.water.ca.gov/waterdatalibrary/
[2] Data provided by *Pucherelli et al. 2016 (BLM)*
[3] Data provided by *Cohen 2005 (prepared for CDWR)*

LAKE COUNTY
Watershed Protection District

Lake County

Quagga and Zebra Mussel Prevention Plan

March 2019

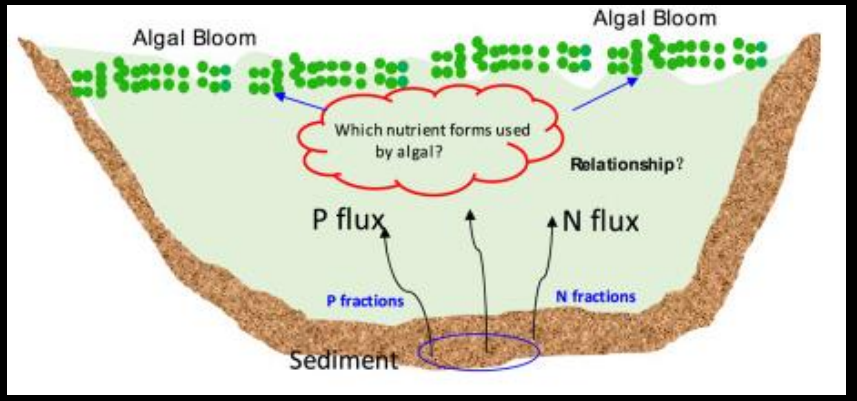
STOP AQUATIC HITCHHIKERS!
Be A Good Steward. Clean. Drain. Dry.
StopAquaticHitchhikers.org

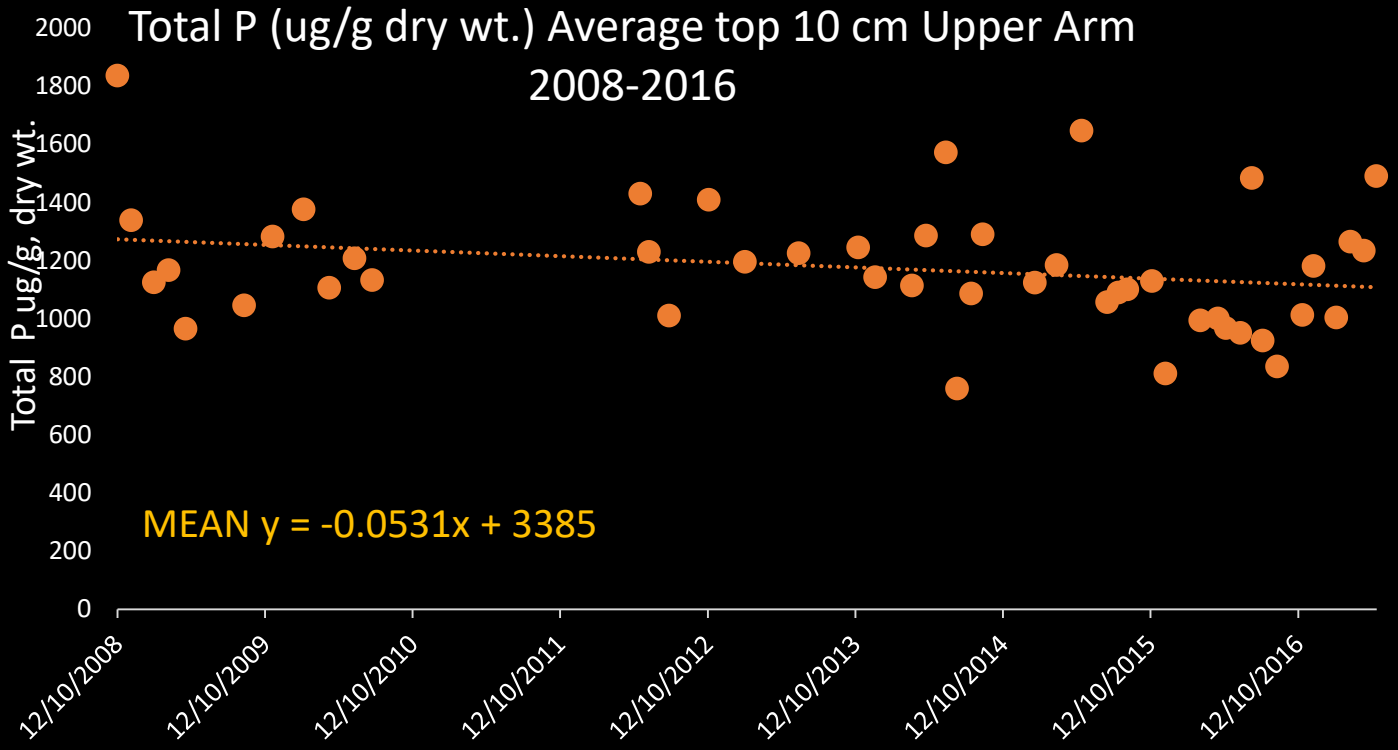
SPREAD THE MESSAGE NOT THE MUSSELS

Sediment Cores - $60,000 / year

2020-2021 – Help from UCDavis / BRC 2020/21 (Thank you!)

N & TP in sediments nutrient bank – explain lake WQ / sediment flux





To Recap County 2021 Annual Costs:

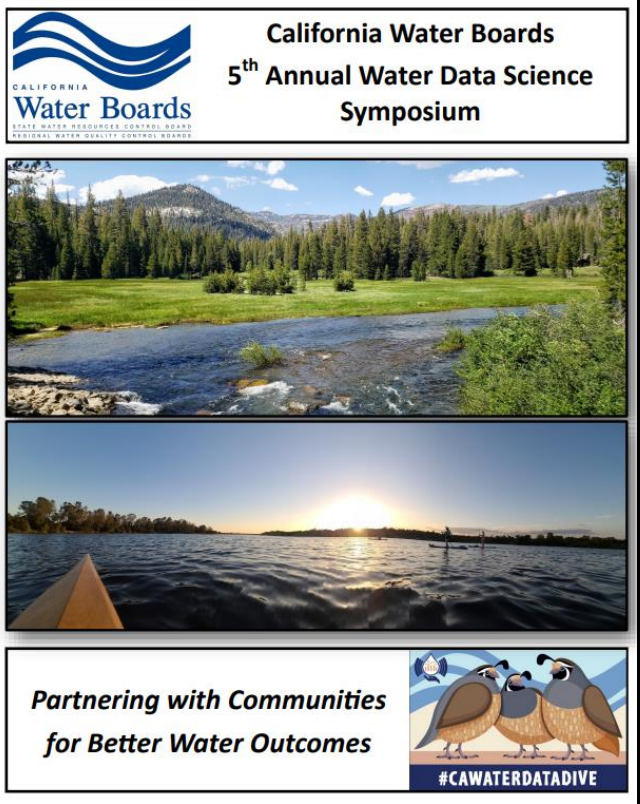
- ~$100,000 + WQ Ambient Monitoring Trial Scheme
- $50,000 / year sediment sampling
  - Supported until June 2021 UC Davis / BRC funds
  - Working with UC Davis on sediment Flux paper
- ~$60,000 year mussel monitoring / WQ monitoring
  - Lakes outside of Clear Lake
  - But important to Lake County Ecology & Economy
- ~$125,000 Expanding Stream and Urban Storm water Monitoring Networks
  - (11 urban discharge sites, 30 stream sites)

No general fund, no fee / tax increases!
Not really sustainable past current grant years!

Next Steps: Data Monitoring Prioritization

- Data Analysis!
- AmeriCorps Civic Spark (Liam)
- Combing through DWR dataset
- Like Statistical Modelling
  - What to keep?
  - What to throw out?
  - Variable Importance / model performance
  - Caret Packaging / Machine Learning
- Liam Presenting this research at 2021 Data Water Symposium
  - Tue, Jun 29, 2021 - Wed, Jun 30, 2021

CivicSpark

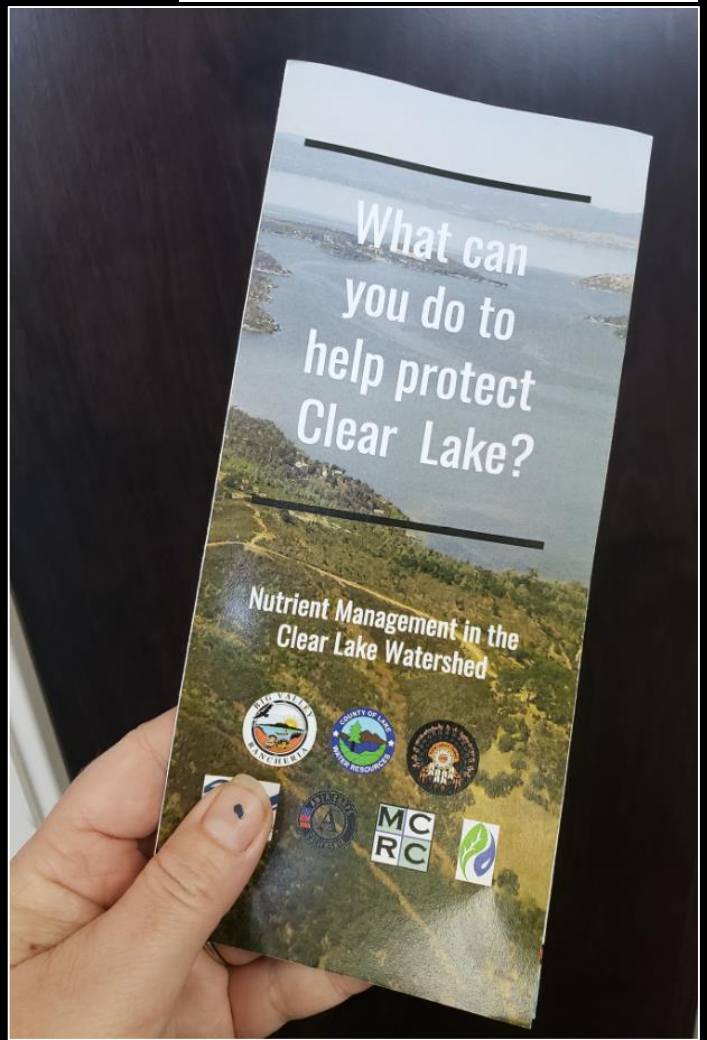


Update on WQ complete Qs?: Angela.DePalma-Dow@lakecountyca.gov

THANK YOU to co-authors & collaborators Ian McCullough & Jennie Brentrup

Outreach Updates

Clear Lake Cyano Task Force Nutrient Brochure



WHERE CAN YOU REPORT ILLEGAL DUMPING OR POLLUTION?

- City of Lakeport (707) 263-5613 ext. 205
- City of Clearlake (707) 994-8201 (press 0)
- Lake County Code Enforcement (707) 263-2309 or email at compliance@co.lake.ca.us
- Lake County Water Resources Dept. (707) 263-2344
- Sewage spills can be reported to Lake County Environmental Health (707) 263-1164
- Report Off Highway Vehicle (OHV) in Cow Mountain recreation area to Ukiah Field Office (707) 468-4000
- Report hazardous material spills to CalOES at 1-800-852-7550

WHY IS LIMITING NUTRIENTS IN THE LAKE IMPORTANT?

When ecologically balanced, Clear Lake has enough nutrients (nitrogen, phosphorus, iron, etc.) for the native plants in its aquatic ecosystem to photosynthesize and grow. The presence of pollutants (toxic chemicals, oils, fecal-coliform bacteria) or excessive amounts of natural or synthetic nutrients disrupts this balance.
High amounts of nutrients cause overgrowth of invasive plants and cyanobacteria (blue-green algae), sometimes called harmful algal blooms (HABs), which can be toxic.

HOW CAN YOU PROTECT THE LAKE WHEN RECREATING?

- Boating in shallow areas agitates nutrient-rich sediment. Reducing boat speed and/or boating activities reduces the amount of sediment released.
- Dredging and shoreline construction activities increase turbidity and erosion in the lake. Follow the Lake County Water Resources Department guidelines for installing silt curtains, turbidity curtains, and fences around all projects occurring in coves, bays, and on the shoreline. These reduce the release of nutrient-rich sediments that sustain algae and cyanobacteria blooms.

HOW CAN YOU IMPROVE STORM WATER QUALITY?

Rainstorm events create storm water which can mix with pollutants in drains, ditches, gutters, and culverts. This untreated storm water flows directly into creeks, streams, rivers, and lakes and pollutes both drinking and recreational water.

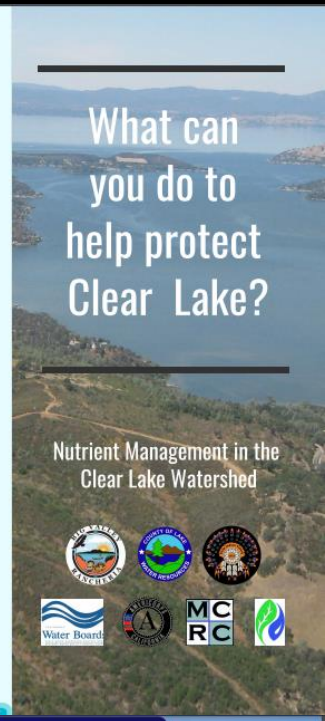
Here's how you can help:

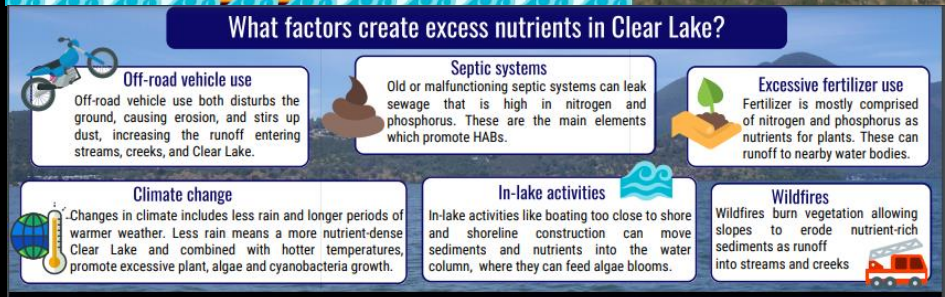
- Don't apply fertilizer before windy or rainy weather
- Place all green waste in the green waste bin, in the trash, or in your yard as compost
- Divert roof water to lawns and gardens so that it soaks in the ground instead of into the storm drain
- Sweep sidewalks and driveways instead of hosing them down
- Plant native species instead. For a list of native plants contact Lake County Resources Conservation District (707) 263-6838
- Keep all pollutants (pesticides, oils, trash) off of streets and slopes and out of gutters, ditches, culverts, and storm drains
- Properly store unused fertilizers and properly dispose of empty containers

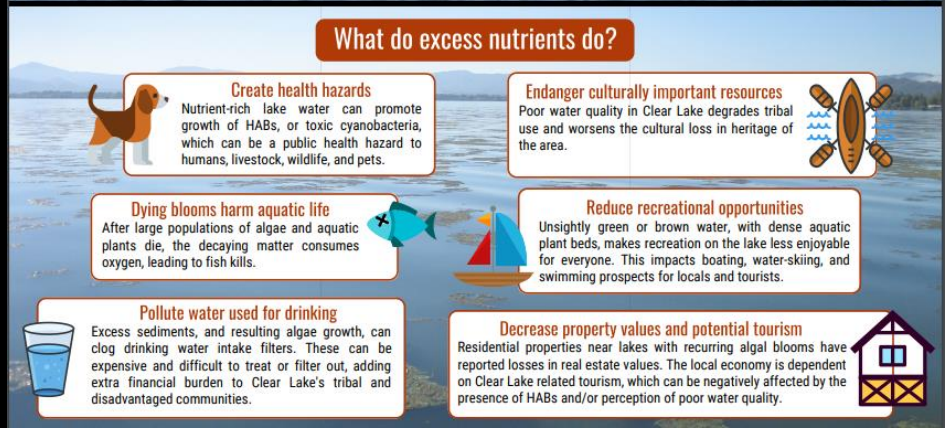
HOW CAN YOU DECREASE NUTRIENT LOADING IF YOU HAVE A SEPTIC SYSTEM?

Septic systems are used when connecting to a sanitary sewer system is impossible. They are onsite wastewater treatment systems for individual households.

- Maintain your septic system and have it inspected by a professional every 3-5 years
- Have your septic system pumped out every 3-5 years. Pumping it every 2-5 years is recommended for a 3 bedroom home with a 1,000 gallon tank. Smaller tanks should be pumped more frequently.
- Minimize garbage disposal use
- Avoid planting shrubs near drain fields; their roots clog drain lines
- Spread out laundry machine use throughout the week to avoid overloading the system. Use the appropriate amount of detergent; more is not better.







NPDES – Clear Lake Aquatic Plant Management Program

Include

- Manual
- Chemical Herbicide treatments
- Herbicide monitoring is VERY expensive
- ~$17,000 / year min
- Cost of permits do not cover this cost